ELLIOTT (A.R.)

A New Method for the Detection and Estimation of Sugar in the Urine.

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AT THE POST-GRADUATE MEDICAL SCHOOL, CHICAGO.

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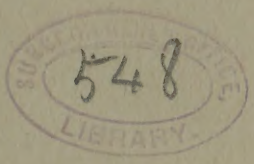

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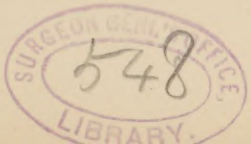
The tests most commonly used for the detection of sugar in the urine are the copper tests, and of these Fehling's method has hitherto been the most popular with the profession. In common with the others of this class, this method depends for its reaction upon the power which grape sugar possesses of reducing cupric oxide to the state of cuprous oxide, with the formation of a yellowish-red precipitate soluble in ammonia. If sugar is present in the urine in any considerable amount, Fehling's test leaves little to be desired as to reliability. When, however, but a small quantity is present, its method of application renders it liable to faulty reduction and misleading results. In dealing with small quantities of sugar in the urine it is anything but a perfect test. Normal urine contains substances which have a marked effect in reducing copper test solutions. The principal of these are uric acid and creatinin. Dr. George Johnson attributes to the former one quarter and to the latter three quarters of this property. They are



constant ingredients of the urine and constitute a fruitful source of error when but slight reduction takes place.

Another occasional cause of faulty reduction of these tests is glycuronic acid. This substance is present in such small quantity in normal urine as to be considered practically absent, but after taking such drugs as chloral hydrate, camphor, and chloroform it may appear in considerable amount. When such is the case it gives rise to a frank reduction, indistinguishable in appearance from that produced by grape sugar.

The large quantity of urine used in the application of Fehling's test renders it especially susceptible to these errors. In applying the test we are directed to add the urine to the boiling test solution until reduction takes place, or until we have added as much urine as we have test solution. The amount of the solution employed is usually one drachm. Such a quantity of normal urine, if it be at all concentrated, will almost invariably give rise to an appreciable reduction, much resembling that due to the presence of small amounts of sugar. It is with urines of high specific gravity that we exercise the greatest care in searching for sugar, and it is in these cases where discrimination is essential that Fehling's method is most misleading. Normal urine is frequently concentrated, of high density, and increased acidity, and in such an event the amount of urine used with this test will contain sufficient creatinin and uric acid to produce a reaction which may, and frequently does, deceive the unwary. If less urine is used the delicacy of the test is impaired. In addition to this serious drawback, the instability of the test solution and its well known tendency under certain circumstances to undergo spontaneous reduction are other objections to its use. Haines's modification is a considerable improvement over Fehling's in manner of application, but leaves much to be desired in point of delicacy.

The ideal test for sugar will be one that is at once reliable and sensitive, recognizing with certainty minute quantities of sugar in the urine, and one that requires the employment of never more than a few drops of urine in its application. Such a one the following method, devised and employed by myself, has thus far proved to be. With great reliability it combines extreme delicacy, and requires the employment of a minimum quantity of urine.

The formulæ for its preparation and the details of its application are as follows:

Solution No. 1.

Cupric sulphate (C. P.)..... gr. xxvij;
Glycerin pure..... ℥ iij;
Distilled water..... ..... ℥ ijss;
Liquor potassæ.....ad ℥ iv.

Dissolve the cupric sulphate in the glycerin and distilled water. Gentle heat will facilitate the solution. When cold, add the liquor potassæ and mix thoroughly.

Solution No. 2 is a saturated solution of chemically pure tartaric acid in distilled water.

The solutions are quite stable and will keep indefinitely.

Into a test tube pour a drachm of the cupric-oxide solution and gently boil over a spirit flame. Then add two or three drops—not more—of the tartaric-acid solution and boil again. Now add the suspected urine slowly, drop by drop, boiling and shaking the test solution between each drop until reduction takes place, or until eight drops of the urine have been added. If no change follows the addition of this amount of urine, sugar is not present. The end reaction is a yellowish or reddish, or sometimes greenish-gray, deposit of suboxide which is marked and unmistakable. If the solution be stood aside for a few moments the reaction deepens.

Applied in this manner, the test will detect less

than one part in a thousand of urine, or one tenth per cent. If sugar be present to any considerable extent, a single drop of urine will promptly develop the reaction. The addition of three drops gives a marked reduction when two grains to the ounce are present, and four drops will detect one grain to the ounce, or one in four hundred and eighty. More than eight drops of urine should never be used with this test, since that amount never fails to give a marked reaction when half a grain or more of sugar to the ounce is present, and smaller traces than this in the urine are of no interest to the practitioner. Greater delicacy may be obtained by the addition of a larger quantity of urine, but by so doing reliability is sacrificed for greater sensitiveness and the especial value of this method is destroyed.

The end reaction developed by the smaller amounts of sugar is a grayish, muddy deposit, easily distinguishable, with disappearance of the blue color of the test solution.

I have adapted this test so that it may be used for the quantitative estimation of sugar. The advantages which characterize it as a qualitative test render it especially applicable for this purpose. Proceed as follows: Take a hundred and thirty-three minims of the cupric-oxide solution in a narrow-necked glass flask and add thereto six drops of the tartaric-acid solution and three drachms of liquor ammoniæ, U. S. P. Mix thoroughly, and add enough distilled water to raise the total volume of the solution to two ounces. The principle of this test is the same as that of Purdy's test and Pavy's ammoniated cupric test, which is that the cuprous oxide formed by the reducing power of the sugar is held in solution by the ammonia, the test solution remaining clear throughout, the end reaction being the complete disappearance of the blue color.

This amount of the solution represents in sugar value

a fourth of a grain of grape sugar—that is, it is reduced and decolorized by exactly a fourth of a grain of sugar. Its application is conducted in the same manner as Pavy's and Purdy's methods. The urine is added to the boiling test solution, drop by drop, until the color has entirely disappeared. The number of minims of urine necessary to produce this result is noted on the burette or minim pipette used, and four hundred and eighty, the number of minims in an ounce, is divided by the number of minims so required, and the product divided by four, which gives the number of grains of sugar to the ounce. Instead of this process the urine, before testing, may be diluted with three volumes of distilled water, and four hundred and eighty, divided by the number of minims required to decolorize the test, will give the number of grains to the ounce of urine. Knowing the total amount of urine for the twenty-four hours, it is a simple matter to estimate the total excretion of sugar.

The delicacy of the test results in a singularly clear and transparent end reaction. This result is also partly due to the fact that the solution, being prepared freshly each time, is clearer and gives more positive results than other tests which, notwithstanding their alleged stability, deteriorate to some extent when kept for long periods of time.

The fact that the same solutions are used for estimation as are employed for the detection of sugar constitutes an advantage, as it avoids multiplicity of reagents.

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